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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OAST SPACE THEME WORKSHOP

VOLUME II

(NASA-TM-80003) OAST SPACE THEME WORKSHOP.
VOLUME 2: THEME SUMMARY. 2: SPACE
INDUSTRIALIZATION (NO. 8). A. THEME
STATEMENT. B. 26 APRIL 1976 PRESENTATION.
C. SUMMARY STATEMENT. D. INITIATIVE

N79-15115

Unclas

G3/12 42656

THEME SUMMARY

II. SPACE INDUSTRIALIZATION (#8)

- A. THEME STATEMENT
- B. APRIL 26, 1976, PRESENTATION
- C. SUMMARY STATEMENT
- D. INITIATIVE ACTION (FORM V)

HELD AT THE
LANGLEY RESEARCH CENTER
APRIL 26-30, 1976

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Foreword

The attached material represents the working papers from the OAST Space Theme Workshop held at the Langley Research Center, April 26-30, 1976, and contains a quick-look analysis of the proceedings. The material is unedited and intended for further use by the participants of the workshop and the planning elements of NASA concerned with space mission research and technology. It should be understood that the data do not represent official plans or positions but are part of the process of evolving such plans and positions.

Nearly 100 of the Agency's top technologists and scientists joined with another 35 theme specialists to produce this working document - a document that provides a technical foundation, including research and technology base candidates, for each of the six space themes.

The material in this report is considered essential to the development of Center initiatives in support of these themes. Copies of the report will be made available to the Center Management Board and the individuals at the Centers responsible for the FY'78 program planning cycle. The timing of this planning activity has caused us to distribute this document in this unedited form. Thus, it possibly contains errors, hopefully, more of a typographical rather than a technological nature. Nonetheless, the information contained is of a high professional level, reflecting the efforts of the workshop participants and will be invaluable to the planning and successful execution of the Agency's near- and far-term advanced technology program.

Stanley R. Sadin
OAST Space Theme Workshop
Chairman
NASA Headquarters
Study, Analysis, & Planning Office
Office of Aeronautics and
Space Technology

4/15/76

Theme 8 Technology for Industrialization of Space

I. BACKGROUND

1. Theme Description

The initial development of space industrialization will be driven by the exploration of solar energy for use on earth and in space. These early large projects, largely involving assembly and maintenance, will likely provide the basis for development of fabrication and manufacturing of specialized products in the near earth environment. Full exploitation of space industrialization must await the creation of long-term habitat/manufacturing facilities in deep space which utilize materials from the moon, the asteroids, and in limited cases from the earth. This activity will include the fabrication of structural elements for the construction of space habitats, large antennas and telescopes, solar power stations, etc.; the gathering the extraterrestrial material resources for processing and the development and operation of manufacturing facilities. In the beginning, the Shuttle will transport the elements of large structures to make up large space structures. Later a large Lift Vehicle and then still later the SSTO will perform the transportation. Ultimately, the moon will become a platform for advanced operations such as the production of structural metals and life supporting oxygen. By then man will have the means to live permanently in space. He can assist in conserving earth's diminishing resources, using solar power directly as a substitute for fossil fuels and extraterrestrial materials for construction of space systems.

I. Background

2. Theme Advocacy

The US space program has proven that man can live and work effectively in space. The time is now ripe to put man permanently in space so he can exploit the opportunities that are offered by the environment, the moon, and perhaps the asteroids and Mars - that is, the time is ripe for Space Industrialization.

The ultimate goal of Space Industrialization is to use the environment of space to: (a) provide a site for the location of hazardous processing of materials and energy; (b) provide resources which on earth are either in limited supply or are obtainable only at the expense of a greatly degraded biosphere; (c) provide long duration weightless and vibration free conditions which are impossible to attain on earth; and (d) provide a substantially increased efficiency for other space operations. If the industrialization of space is to be practical, we must produce the technology to live, explore, and to manufacture, and the means to do so at the lowest possible cost.

A. Space offers a unique opportunity to minimize the polluting effects and potentially hazardous aspects of many of our currently earth based industries. Large nuclear power plants could be placed in geosynchronous orbit with microwave or laser transmission of the energy back to earth. This would virtually eliminate all the environmental and safety concerns currently plaguing the development of energy

independence through the use of nuclear power. Toxic chemicals could be processed in space, where no chance of contamination of people or the biosphere would exist. Industries which have large effluent discharges, either in the form of heat or chemicals, and which may effect the steady state balance of our biosphere could be moved into space where no damage can be done. During the last 20-30 years the world's temperature has fallen on the order of .5 °C. This has been accompanied by significant changes in the circulation patterns of the atmosphere which determine weather. This may be the first evidence of our polluting earth based industry dramatically affecting the habitability of our biosphere. Space based industry would not have this affect.

B. Virtually all the world's peoples should be able to hope that human conditions will improve and that there might be means for them to achieve a standard of living higher than that they currently enjoy. However, the recent oil embargo and shortages of raw materials have highlighted the precarious situation facing the world today. Much of the non-western world is now consuming energy at a growth rate greater than the US and it is expected that the world as a whole will use up as much energy between 1970 and 2000 as it did for the total period of time up until 1970. Clearly alternate means of obtaining energy are necessary.

The source of virtually all our energy is the sun - fossil fuels being but one example of storage of that energy. Through solar power stations the undiminishing energy from the sun can be made available directly in almost unlimited quantities.

(For more complete discussion, see the OFS Report p.81-86.)

The shortage of minerals is predicted to become acute in a few years unless low grade ores are mined; such mining requires a large increase in energy consumption. At some point in the future it may become cost effective to process some minerals into products on the moon and ship them to Earth or to facilities in Earth orbit. The effects of obtaining cheap resources from space would be to ease the demand for energy and minerals obtained from Earth, to reduce international tensions generated by competition for these resources, and to increase the average standard of living for all nations.

The Apollo Program has confirmed the moon as a source of many minerals. Present on the moon are oxygen for life support and rocket propulsion; metals such as Al, Mg, Fe, and Ti for structural materials and rocket propulsion; ceramics and glass for construction; silicon for photovoltaic devices; and thorium for nuclear breeder reactor fuels. Although the processing of lunar construction materials, such as melting rock into glass, will require considerable

energy, it can be made readily available through the use of solar power stations. At a later time, asteroids might be used as a source of raw materials.

A substantial portion of many future space structures, habitats, vehicles, etc., could be built from lunar materials and launched from the Moon into geosynchronous orbit, the escape energy required would be only one-twentieth as much - a negligible fraction of the requirement of launchings from Earth. Thus, a lunar industry capable of manufacturing space structures, e.g., space power stations could be worth tens of billions of dollars a year.

C. Space offers the environment of long duration weightlessness, an environment that can only be created for a few seconds on Earth. This extraordinary environment promises humanity opportunities for research in the physical and life sciences for processing organic and inorganic materials, and for creating products heretofore unavailable or too expensive to produce on Earth.

The processing of materials in the low-gravity available from 0-g in Earth orbit or 1/6th g on the moon will benefit through 1) reduced fluid convection as a result of density differences; 2) greater influence of surface tension in the behavior of melts; 3) reduced plastic or viscous deformation in materials; and 4) reduced density separation in suspensions.

Space also offers a unique vibration free environment. Nowhere on earth can this same condition be created.

D. Space Industrialization will provide an additional benefit -- that is, virtually all other space activities, certainly all those requiring large structures, will be able to be implemented more easily and efficiently. The materials being processed in space will be available for use without needing to be transported from earth. The many tools, techniques, facilities developed for Space Industrialization will also be available. There will not be a need to continue the current philosophy of building in automated systems with double and triple redundancy.

Construction, repair, and operation of the space systems from space itself will become as routine as earth based operations are today.

II. Technology Needs

1. Enabling Technology Needs & Requirements

The following broad technology areas have been identified as necessary for supporting this theme:

- a. Large Space Structures: Concepts, Designs,
Fabrication, Assembly,
Control
- b. Fabrication and Joining Processes
- c. Advanced Space Transportation Systems
- d. Space Power Systems - Nuclear and Solar
- e. Robotics/Teleoperators
- f. Biotechnology in Space
- g. Artificial Gravity
- h. Utilization of Lunar Materials for Construction
- i. Extraction of Oxygen and Metals from Lunar Resources

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2. Specific Technical Activity (Projected)*

The following FY 78 "New Initiatives" are those identified as being pertinent to this theme. The first eleven were submitted by the NASA Centers; the last two were identified as being necessary and recommended for implementation by Headquarters for FY 78. The complete write-up for each of the Center-submitted initiative will be available in a separate package.

Direct Support

1. N.I. No. 114 Large Area Space Structures
2. N.I. No. 127 STEV/MIPTL
3. N.I. No. 122 Oasis
4. N.I. No. 104 Dexterous Manipulator

Generically or Partly Related

5. N.I. No. 106 Nuclear Thermionic Power
6. N.I. No. 130 Orbital Demonstration of Large Structures
7. N.I. No. 116 Structures for Advanced Transportation Systems
8. N.I. No. 117 Advanced Dual Fuel Propulsion Systems
9. N.I. No. 118 Sphinx B/C
10. N.I. No. 119 Recast (Cryogenic Engine Systems)
11. N.I. No. 111 Thermal System Design

Task Team Identified

12. Extraterrestrial Materials Processing
13. Habitat/Life Support

III. Working Groups Directive

The function of the OAST Technology Working Groups is to identify and develop the required technologies for each of the Space Themes. In regard to the theme on Technology for Industrialization of Space, all Working Groups should first ascertain if they can contribute to this theme. If affirmative, the Working Groups should then review/revise the FY 78 New Initiatives from the standpoint of their completeness. Technology gaps should then be identified, developed in terms of brief descriptions, objectives, schedule, and resources. Finally, the technologies/initiatives should be prioritized.

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Appendix

Theme Team

NASA

G. C. Deutsch (Chairman)	Hqs. - OAST
J. J. Gangler	Hqs. - OAST
A. Chambers	ARC
E. Kruszewski	LaRC
C. Blankenship	LeRC
J. W. Stearns	JPL
D. S. McKay	JSC
E. C. Cataldo	MSFC
J. H. Von Puttkamer	Hqs. - OAST

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THEME NO. 8 TECHNOLOGY FOR INDUSTRIALIZATION OF SPACE

APRIL 26, 1976

PRESENTATION

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11-11B

TECHNOLOGY FOR INDUSTRIALIZATION OF SPACE

OBJECTIVE

GENERAL: PROVIDE THE TECHNOLOGIES TO PERMIT MAN TO LIVE AND WORK IN SPACE

SPECIFIC: PROVIDE FACILITIES FOR:

1. GENERATION OF SOLAR POWER FOR USE ON EARTH
2. SPACE PROCESSING OF HAZARDOUS MATERIALS TO PROTECT THE BIOSPHERE
3. SPACE PROCESSING OF BIOLOGICALS AND MATERIALS FOR ADDED VALUE AND CONSUMPTION ON EARTH
4. SCIENCE

TECHNOLOGY FOR INDUSTRIALIZATION OF SPACE

WHY?/BENEFITS

- 0 SOLAR POWER TO REPLACE DWINDLING FOSSIL FUELS
- 0 PROTECT THE BIOSPHERE - TRANSFER OF TOXIC AND HAZARDOUS OPERATIONS FROM EARTH TO SPACE
- 0 SPACE PROCESSING OF BIOLOGICALS AND MATERIALS FOR EARTH CONSUMPTION
- 0 SCIENCE

TECHNOLOGY FOR INDUSTRIALIZATION OF SPACE

TECHNOLOGY AREAS OF EMPHASIS

O LARGE SPACE STRUCTURES

- CONCEPTS
- DESIGNS
- ASSEMBLY
- FABRICATION
- JOINING
- CONTROL

O ADVANCED SPACE TRANSPORTATION SYSTEMS

- SSTO
- HEAVY LIFT VEHICLES

O SPACE POWER

- NUCLEAR
- SOLAR

TECHNOLOGY AREAS OF EMPHASIS (CONTINUED)

- O AUTOMATIC MANIPULATORS
- O ROBOTICS/TELEOPERATORS
- O THERMAL DESIGN/CONTROL
- O LIFE SUPPORT
- O RADIATION EFFECTS/SHIELDING
- O ARTIFICIAL GRAVITY
- O UTILIZATION OF LUNAR MATERIALS FOR CONSTRUCTION
- O EXTRACTION OF OXYGEN AND METALS FROM LUNAR RESOURCES

TECHNOLOGY FOR INDUSTRIALIZATION OF SPACE

FY 78 NEW INITIATIVES

DIRECT SUPPORT:

- #104 - DEXTEROUS MANIPULATOR
- #114 - LARGE AREA SPACE STRUCTURES
- #122 - OASIS
- #127 - STEV/MIPTL

PARTLY RELATED:

- #106 - NUCLEAR THERMIONIC POWER
- #111 - THERMAL SYSTEM DESIGN
- #116 - STRUCTURES FOR ADVANCED TRANSPORTATION SYSTEMS
- #117 - ADVANCED DUAL FUEL PROPULSION SYSTEMS
- #118 - SPHINX B/C
- #119 - RECEST (CRYOGENIC ENGINE SYSTEMS)
- #130 - ORBITAL DEMONSTRATION OF LARGE STRUCTURES

TECHNOLOGY FOR INDUSTRIALIZATION OF SPACE

WORKING GROUPS DIRECTIVE

- O REVIEW/MODIFY/RECOMMEND NEW INITIATIVES
- O IDENTIFY TECHNOLOGY GAPS
- O CONSTRUCT TIME TABLE FOR TECHNOLOGY TASKS
(PRIORITIZE)

TECHNOLOGY FOR INDUSTRIALIZATION OF SPACE

SCENARIO

- PRESENT: LIGHTWEIGHT MATERIALS (COMPOSITES)
STRUCTURES CONCEPTS/DESIGNS
THERMAL CONTROL
TPS
- 1978: LARGE SPACE STRUCTURES DESIGNS
ORBITING POWER SOURCE
AUTOMATED MANIPULATORS
- 1980: DEMONSTRATION OF SIMPLE STRUCTURES
IN SPACE

SPACE STATION STRUCTURES CONCEPTS
AND DESIGNS

SPACE POWER DEVELOPMENT (10'S KW)
COMPOSITES FOR ADVANCED STS
- 1985: SPACE POWER (MW)

DEMON./ASSEMBLE SPACE STATION STRUCTURES

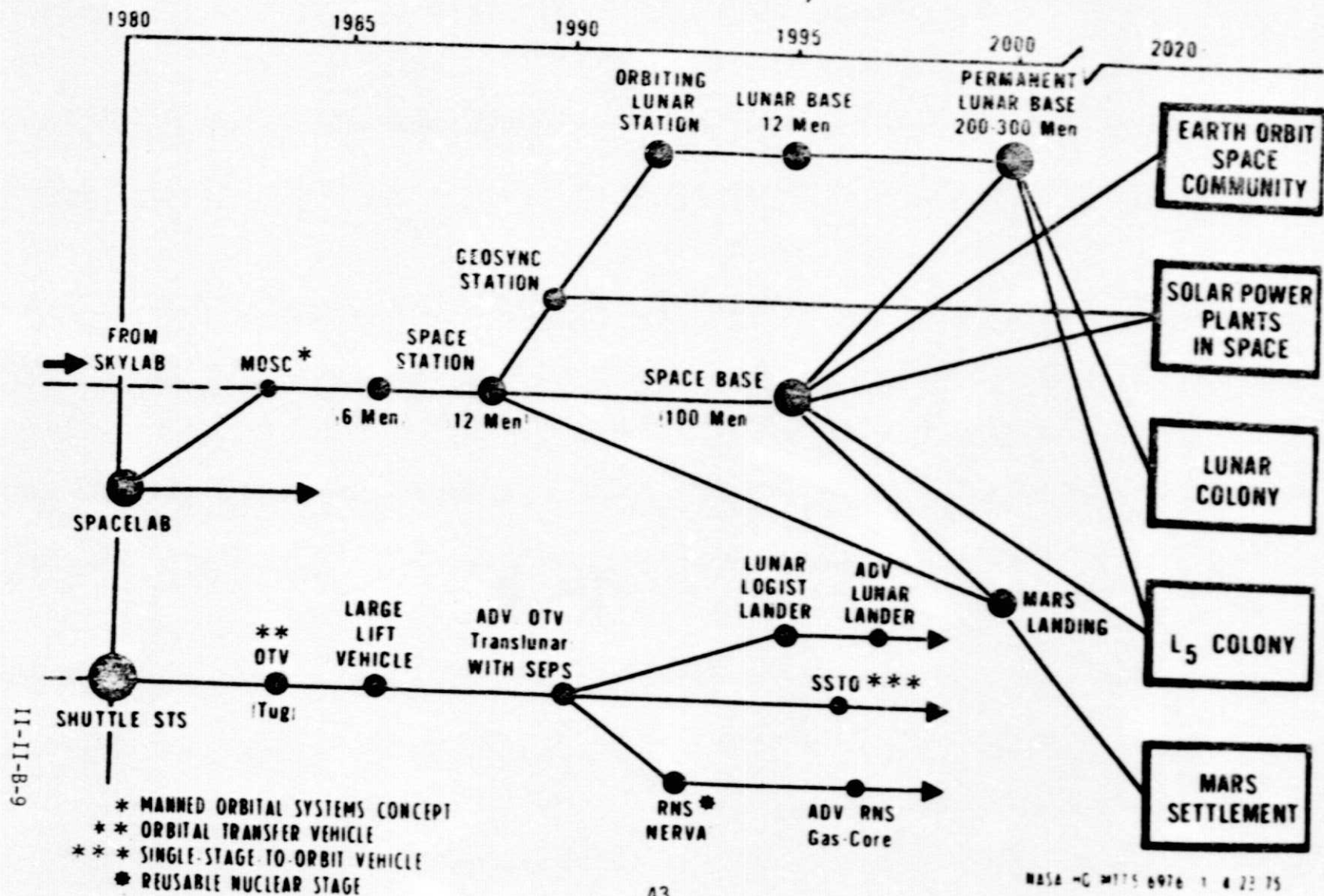
LUNAR BASE STRUCTURES CONCEPTS/DESIGNS

UTILIZATION OF LUNAR MATERIALS

STRUCTURES FOR SPACE PROCESSING FACILITY

ROBOTICS/TELEOPERATORS FOR MFG. FACILITIES
- 1990: LUNAR MFG./MATERIAL HANDLING FACILITY

EVOLUTIONARY PATHS TO FAR-FUTURE SPACE ENDEAVORS (Relevance Tree)



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B. Technology for Industrialization of Space (TT-#8)

Discussions with the Working Groups indicated that this theme had been well defined. The needs and benefits associated with this theme were acceptable and the major areas of technology had been identified. There was agreement that the following technologies were pertinent to this theme:

Large Space Structures	Life Support
Advanced STS	Artificial Gravity
Space Power	Automatic Manipulators
Thermal Design/Control	Radiation Effects/Shielding
Manipulators/Teleoperators/Robotics	
Lunar Materials for Construction	
Extraction of Oxygen and Metals from Lunar Resources	

The major needs/initiatives were identified as follows:

- (1) Large Area Space Structures (No. 114)
- (2) Long Life Orbiting Power Station (No. 122, OASIS)
- (3) Attitude, Figure, Pointing, Control of Large Space Structures.
- (4) Manipulators, Teleoperators, Robotics
- (5) High Specific Impulse Orbiter Transfer Vehicle

The ranking of these needs/initiatives are presented on Form 5, Figure III B-1 as follows:

OVERALL THEME TECHNOLOGY RANKING AND
INITIATIVE ACTION

TT Tech. for Industrial. of Space FORM V
PAGE 1

DATE 4/ 28/76

TECHNOLOGY NEED NO	OVERALL T.T PRIORITY	INITIATIVE ACTION		
		REVISE EXISTING INITIATIVE	DRAFT NEW INITIATIVE	NONE REQUIRED
8M-2/1, 2, 3,				
8M-1/4, 7				
7M-1/5 Large Space	1	X		
11M-1/2 Structures				
12M-1/5				
5-6 OASIS	2		X	
* E-1/15 Attitude of Space Struc E-3/1	3		X	
E-1/23 Teleoperators	4		X	
P-1/12, 13, 49 Hi. Sp. Imp. OTV	5		X	
* Should be developed in tandem.				

FIGURE III B-1

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11-11-D-1

5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

LEVEL OF STATE OF ART
1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED

SPACE TECHNOLOGY NEED

FORM NO. 1

PAGE 1 OF 2

1. TITLE Space industrialization - Extrapolation NO. #8/Theme #8/1
from the Terrestrial (V.S.) Economy THEME / W.G. / TASK
DATE 4 / 29 / 76

2. OBJECTIVE

Develop econometric model of an advanced industrial economy in which
physical parameters unique to space are independent variables.

3. NEED ANALYSIS *Not considered

- a) LEVEL NOW ☒ , WILL BE LEVEL ☐ UNDER EXISTING PLANS.
b) REQUIRED ADVANCEMENT - SHOULD BE TECHNOLOGY READY
AT LEVEL ☐ FOR OPERATIONAL SYSTEM USE BY DATE: 1978
c) RISK IN ACHIEVING ADVANCEMENT:
HIGH ☐ MEDIUM ☐ LOW ☒
d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING ☐ OR
ENHANCING: HIGH ☒ MEDIUM ☐ LOW ☐
e) TASKS NEEDED: STUDY ☐ ANALYSIS ☒ RESEARCH ☐
GRD TEST ☐ AIR CRAFT TEST ☐ SPACE FLIGHT TEST ☐
OTHER (Specify) ☐ (Check one or more)
f) R&T BASE CANDIDATE Yes

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR USE OF THIS TECHNOLOGY

None. Involves development of computer models
of industrial groups.

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED - None.

Zero-gravity, low-gravity gradients, vacuum, plentiful solar energy and
other aspects of the space environment are widely mentioned as affording
basis advantages to industry in space. Available econometric models of
industrial economies should be modified to include the effects of these
physical conditions in parametric forms on efficiencies, throughputs,
transportation, etc., in order to identify industrial groups which might
derive benefits from operations in space under particular explicit
conditions.

5. COMPONENT OR BREADBOARD TESTED IN RELEVANT ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

LEVEL OF STATE OF ART
1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED

SPACE TECHNOLOGY NEED

FORM NO. 1

PAGE 1 OF 2

1. TITLE Photovoltaic Conversion -- Production
of Cells From Lunar Materials

NO. 8 / 8 / 3
THEME / W.G. / TASK

DATE 4 / 30 / 76

2. OBJECTIVE Develop concepts for production of solar cells from lunar
materials either on the Moon or in space.

3. NEED ANALYSIS

- a) LEVEL NOW ☒ 1, WILL BE LEVEL ☒ 1 UNDER EXISTING PLANS.
- b) REQUIRED ADVANCEMENT - SHOULD BE TECHNOLOGY READY
AT LEVEL ☒ 3 FOR OPERATIONAL SYSTEM USE BY DATE: N/A
- c) RISK IN ACHIEVING ADVANCEMENT:
HIGH ☐ MEDIUM ☒ LOW ☐
- d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING ☒ JR
ENHANCING: HIGH ☐ MEDIUM ☐ LOW ☐
- e) TASKS NEEDED: STUDY ☒ ANALYSIS ☒ RESEARCH ☐
GRD TEST ☐ AIR CRAFT TEST ☐ SPACE FLIGHT TEST ☐
OTHER (Specify) ☐ (Check one or more)
- f) R&T BASE CANDIDATE Yes (1977)

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR
USE OF THIS TECHNOLOGY Not defined

5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO ACCOMPLISH NEED

- (1) Conceptional exploration required first in preparation of
needed technological advancements.
- (2) If feasible, then thick solar cells could be produced which are
intrinsically radiation resistant. Costs would then be governed by
cost of transport of production machinery to the Moon or the bulk
material from the lunar surface to deep space.

SPACE TECHNOLOGY NEED

FORM NO. 1

PAGE 2 OF 2

TITLE Space Industrialization - Extrapolation
from the Terrestrial (V.S.) Economy

NO. #8/Theme #8/1

THEME / W.G. / TASK

DATE 4 / 29 / 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

Form study group composed of industrial economists, process and civil
engineers, physicists, and chemists to formulate critical physical
parameters of industrial economy, incorporate them as adjustable
parameters into available econometric models and conduct parametric
analyses.

7. ALTERNATIVE APPROACHES/OPTIONS Perform large number of product-specific
studies which means that only people already interested in space
production participate.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

None.

9. TECHNOLOGY SCHEDULES

FY

SCHEDULE ITEM	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
TASK ITEM																				
1. Study Group formulated																				
2. Parametric formulations																				
3. Econometric Studies																				

MANPOWER (M-Y)

INHOUSE

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CONTRACT

.5 6 6

FUNDING (10⁶ \$)

INHOUSE

- - .11

CONTRACT

.1 .3 .5

SPACE TECHNOLOGY NEED

FORM NO. 1
PAGE 2 OF 2

TITLE Photovoltaic Conversion -- Production of
Cells From Lunar Materials

NO. 8 / 8 / 3
THEME / W.G. / TASK

DATE 4 / 30 / 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

- (1) Identify techniques for preparation of ultrapure silicon from lunar material.
- (2) Explore possible technologies for production of solar cells from the semiconductor grade material.
- (3) Specialize the possible technologies to lunar surface or space operations.

7. **ALTERNATIVE APPROACHES/OPTIONS** Development of solar reflectors from lunar materials for use in heat cycle electrical generators.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

None

9. TECHNOLOGY SCHEDULES

FY

[illegible]

SPACE TECHNOLOGY NEED

FORM NO. 1

PAGE 1 OF 2

1. TITLE Unmanned Lunar Fabrication
Module (ULFM)

NO. 8 / 8 / 2
THEME / W.G. / TASK

DATE 04 / 30 / 76

2. OBJECTIVE

Explore concepts for production of lunar facilities
utilizing a remotely controlled device no larger than
an Apollo lunar module

3. NEED ANALYSIS

- a) LEVEL NOW ☐ 1 WILL BE LEVEL ☐ 1 UNDER EXISTING PLANS.
- b) REQUIRED ADVANCEMENT - SHOULD BE TECHNOLOGY READY
AT LEVEL ☐ 5 FOR OPERATIONAL SYSTEM USE BY DATE: 1985
- c) RISK IN ACHIEVING ADVANCEMENT:
HIGH ☒ MEDIUM ☐ LOW ☐
- d) CRITICALITY TO THE ACCOMPLISHMENTS: ENABLING ☒ OR
ENHANCING: HIGH ☐ MEDIUM ☐ LOW ☐
- e) TASKS NEEDED: STUDY ☒ ANALYSIS ☒ RESEARCH ☒
GRD TEST ☒ AIR CRAFT TEST ☐ SPACE FLIGHT TEST ☐
OTHER (Specify) ☐ (Check one or more)
- f) R&T BASE CANDIDATE Yes

4. COMPLEMENTARY TECHNOLOGY ADVANCEMENTS REQUIRED FOR
USE OF THIS TECHNOLOGY Not identified at present5. SPECIFY TECHNOLOGY ADVANCEMENT REQUIRED TO
ACCOMPLISH NEED

The objective would be to utilize only available technology but
organize it to this specific objective with restriction on device
size to that which can be soft landed on the moon with boosters
available in the early 1980 time frame. (Concept development)

5. COMPONENT OR BREAKDOWN TESTED IN RELEVANT
ENVIRONMENT IN THE LABORATORY
6. MODEL TESTED IN AIRCRAFT ENVIRONMENT
7. MODEL TESTED IN SPACE ENVIRONMENT

LEVEL OF STATE OF ART
1. BASIC PHENOMENA OBSERVED AND REPORTED
2. THEORY FORMULATED TO DESCRIBE PHENOMENA
3. THEORY TESTED BY PHYSICAL EXPERIMENT OR
MATHEMATICAL MODEL
4. PERTINENT FUNCTION OR CHARACTERISTIC DEMONSTRATED

SPACE TECHNOLOGY NEED

FORM NO. 1
PAGE 2 OF _____

TITLE Unmanned Lunar Fabrication Module (ULFM)

NO. 8 / 8 / 2
THEME / W.G. / TASK

DATE 04 /30 / 76

6. RECOMMENDED APPROACH/PROGRAM PLAN TO ACCOMPLISH NEED

- (1) Identify a major product of ULLM (suggest - construction of a closed-gas cannon or linear-induction-motor system for ejection of lunar materials into space)
- (2) Detail production possibilities for available lunar materials.
- (3) Using presently available technology can such a device be conceived which requires only solar energy for power.

7. **ALTERNATIVE APPROACHES/OPTIONS** Ease requirements by allowing limited materials shipment from earth and if necessary orbital or nuclear power source.

8. CURRENT/PLANNED RELATED ACTIVITIES (RTOP, OTHER)

None

9. TECHNOLOGY SCHEDULES

FY

[illegible][illegible]